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Original Article

Effect of self-ligating brackets on periodontal tissues and inflammatory factors in patients with chronic periodontitis undergoing orthodontic treatment

Zhou Wang[1], Yiqun Wang[3], Yijun Yan[2], Lian Zeng[1]

Departments of [1]Oral Medicine, [2]Nuclear Medicine, Yunnan Second People's Hospital, Kunming, Yunnan Province, China; [3]Department of Stomatology, The First People's Hospital of Qujing City, Qujing, Yunnan Province, China

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Abstract: Objective: Our aim was to investigate the influence of self-ligating brackets (SLBs) on periodontal tissues and inflammatory factors in patients with chronic periodontitis undergoing orthodontic treatment. Methods: We conducted a prospective study on 110 patients with chronic periodontitis and randomly divided them into the research group (n=55) and the control group (n=55). Both groups were treated with straight-wire appliances. Conventional brackets were applied in the control group, while SLBs were adopted in the research group. Moreover, the periodontal status, and the levels of inflammatory factors and prostaglandin E2 in gingival crevicular fluid and serum of both groups were compared before treatment and at 2 months after treatment. Results: At 2 months after treatment, both groups revealed much better results regarding the clinical attachment loss, sulcus bleeding index, gingival recession, plaque index, tooth mobility and gingival recession as compared with those before treatment; more significant changes were identified in the research group (all $P<0.01$). At 2 months after treatment, both groups demonstrated greatly lower levels of tumor necrosis factor-α, interleukin-1β, soluble intercellular adhesion molecule-1 and prostaglandin E2 in gingival crevicular fluid and serum as compared with those before treatment; the levels above were markedly lower in the research group than in the control group (all $P<0.01$). Conclusion: SLBs for patients with chronic periodontitis undergoing orthodontic treatment can significantly alleviate inflammatory reactions, improve periodontal status and exert favorable effects on teeth.

Keywords: Self-ligating bracket, chronic periodontitis, periodontium, inflammatory factor, prostaglandin E2

Introduction

Periodontitis, a common periodontal disease, manifests as chronic inflammation of the supporting tissues of teeth, mostly resulting from disease-associated multispecies bacterial community in the subgingival region. A study from South Korea shows that more than 65% of adults suffer from different degrees of periodontal disease [1]. Since patients with periodontitis often have atypical dental symptoms at early stages due to the slow onset and intermittent active phase, the disease can be easily overlooked [2]. Long-term periodontal disease can cause persistent damage to periodontal tissues. Upper incisor inclination, tooth migration, anterior tooth space, etc. may occur initially, and malocclusion, tooth mobility and even tooth drop can ultimately occur [3]. Orthodontic treatment, which can enhance occlusal stability and improve dental esthetics, has been recognized as an extremely effective adjunctive treatment for chronic periodontitis [4]. Although conventional brackets show favorable outcomes in correcting tooth misalignment, patients still endure obvious pain at the early stage with a high incidence of tooth drop, which results in treatment interruption [5]. A self-ligating orthodontic technique is a new correction technique that has been rapidly developed in recent years and can significantly reduce plaque retention and make oral cleaning easier, with convenient operation and little friction. Thus, the technique is widely favored by clinical orthodontists and patients [6]. Currently, studies of self-ligating orthodontic

techniques mainly focus on periodontal status. Herein, we further explored the effects of conventional brackets and self-ligating brackets (SLBs) on the levels of inflammatory factors and other factors in serum and gingival crevicular fluid (GCF) of patients with chronic periodontitis. Our aim was to compare the effects of the two orthodontic techniques on the oral microecological environment, so as to provide a better treatment regime for clinicians.

Materials and methods

General data

A prospective study was conducted on 110 patients with chronic periodontitis who received orthodontic treatment in Yunnan Second People's Hospital from July 2018 to January 2020. All patients were randomly divided into the research group and the control group by a random number table, with 55 cases in each group. The general data of both groups are shown in **Table 1**. Written informed consent was obtained from each patient and this study was approved by the Ethics Committee of Yunnan Second People's Hospital.

Patients were included if they were aged 18-40 years; had good oral hygiene and normal oral mucosa; received periodontal initial therapy before orthodontic treatment and were in the stable phase of chronic periodontitis [7]; and had return visits regularly.

Additionally, patients with dental caries, >50% of alveolar bone loss, history of hormone administration within 2 months before enrollment, or smoking, and major organ diseases (e.g., heart, liver and kidney diseases) were excluded. Patients during lactation or pregnancy and those who participated in other research projects at the same time were also excluded.

Methods

Both groups were treated with straight-wire appliances for 12 months. Conventional brackets were applied in the control group, while SLBs were used in the research group. For patients with SLBs, the dental arch was aligned and leveled using Ni-Ti arch wires, and the arch width was adjusted using stainless steel ligatures. The bracket was locked into position after being fixed well on the tooth, and then the patients were asked whether or not there was any discomfort in the oral cavity. If there was no problem, patients were instructed to return to the hospital at 2 months after treatment to adjust the brackets at that time.

Outcome measures

The periodontal status of both groups, such as clinical attachment loss (CAL), sulcus bleeding index (SBI), gingival recession (GR), plaque index (PLI) and tooth mobility (TM) was recorded and compared before treatment and at 2 months after treatment [8]. Venous blood and GCF samples (about 5 mL, respectively) were collected from each patient before and after treatment (2 months after treatment) in both groups, and the steps were given as below [9]. Supragingival calculus and plaque were removed, the mouth was washed 2-3 times with pure water, moisture control was obtained using cotton rolls, and then the test tooth surface was dried by an air gun with gentle flowing for 1 min. Subsequently, the sterile filter paper strips were vertically inserted into the sulcus at mesial and distal locations on the labial surface of test teeth, and stopped when resistance was encountered. After about 30 s, the GCF filter strips were taken out and placed into a microcentrifuge tube. Then the GCF weight was calculated using the reducing weight method, and the GCF filter paper strips were packed with tinfoil and stored at a low temperature for use; the blood samples were centrifuged after coagulation to separate the serum. Moreover, the levels of inflammatory factors such as tumor necrosis factor-α (TNF-α), interleukin-1β (IL-1β), soluble intercellular adhesion molecule-1 (sICAM-1) and prostaglandin E2 (PGE2) in GCF and serum were determined by double antibody sandwich enzyme-linked immunosorbent assay (ELISA). The kits were provided by Shanghai Enzyme-linked Biotechnology Co., Ltd. (ml077385, ml058059, ml023294 and ml024761, respectively; China).

Statistical analysis

All data analyses were performed with the SPSS 20.0 software. Chi-square test (χ^2 test) was applied for the comparison of enumeration data expressed as the case/percentage (n/%). The measurement data with a normal distribution were expressed as mean ± standard deviation ($\bar{x} \pm sd$). Independent t-test was adopted

Table 1. Comparison of general data (n, $\bar{x} \pm sd$)

Index	Research group (n=55)	Control group (n=55)	χ^2/t	P
Sex			0.910	0.340
Male (n)	29	24		
Female (n)	26	31		
Age (year)	29.5±3.2	28.8±3.8	1.045	0.298
BMI (kg/m^2)	22.36±1.95	22.74±1.82	1.057	0.293
Disease course (year)	3.2±0.9	3.4±1.0	1.102	0.273
Tooth mobility			0.379	0.827
I (n)	20	17		
II (n)	28	30		
III (n)	7	8		
Plaque index			2.320	0.313
I (n)	20	23		
II (n)	17	21		
III (n)	18	11		

Note: BMI: body mass index.

for the comparison between the two groups and the paired t-test was used for the comparison before and after treatment within the same group. P<0.05 was considered statistically significant.

Results

General data

There was no significant difference in sex, age, disease course, etc. between the two groups (P>0.05), suggesting the two groups were comparable. See **Table 1**.

Comparison of periodontal status before and after treatment

The CAL, SBI, PLI, TM and GR of both groups delivered much better results at 2 months after treatment as compared to those before treatment, while the research group indicated greater changes than the control group (P<0.01). See **Table 2**.

Comparison of inflammatory factor levels in GCF and serum before and after treatment

The levels of TNF-α, IL-1β and sICAM-1 of both groups decreased significantly at 2 months after treatment as compared to those before treatment, while the research group showed a greater decrease in the levels than the control group (all P<0.01). See **Tables 3** and **4**.

Comparison of PGE2 levels in GCF before and after treatment

The PGE2 levels in GCF decreased significantly in both groups at 2 months after treatment as compared to those before treatment, while the research group revealed a greater decrease in the PGE2 levels in GCF than the control group (all P<0.001). See **Table 5**.

Comparison of PGE2 levels in serum before and after treatment

The PGE2 levels in serum reduced markedly in both groups at 2 months after treatment as compared to those before treatment, while the research group demonstrated a greater decrease in the PGE2 levels in serum than the control group (t=5.179, P<0.001). See **Figure 1**.

Discussion

Self-ligating orthodontic techniques are widely used for orthodontic treatment in clinical practice. Compared with conventional brackets, self-ligating brackets deliver the advantages of reduced friction, which is conducive to tooth movement, ameliorating discomfort and shortening the treatment cycle by its movable components to fix the arch wire [10].

In our study, the CAL, SBI, PLI and TM values were all lower, and GR was higher in the research group than in the control group, suggesting that self-ligating brackets for chronic periodontitis patients undergoing orthodontic treatment can alleviate the stimulation of brackets to periodontal tissues greatly, reduce dental plaque, and improve periodontal status and oral hygiene, which was consistent with the results reported by Dehbi et al. [11]. Periodontal status is a commonly used as an extremely important indicator for evaluating the therapeutic effect of chronic periodontitis clinically. In detail, CAL reflects the destruction condition of tooth supporting tissues, with higher values indicating more severe destruction; SBI is applied for evaluating the status of gingival bleeding in periodontal diseases; PLI is

Table 2. Comparison of periodontal status before and after treatment ($\bar{x}$ ± sd)

Group	Time	CAL (mm)	SBI	GR	PLI	TM (mm)
Research group (n=55)	Before treatment	1.66±0.37	1.83±0.37	0.38±0.10	2.26±0.74	1.21±0.33
	2 months after treatment	1.01±0.22***,###	1.19±0.29***,###	0.58±0.13***,##	0.77±0.23***,###	0.46±0.11***,###
Control group (n=55)	Before treatment	1.71±0.34	1.89±0.40	0.35±0.11	2.10±0.81	1.17±0.30
	2 months after treatment	1.29±0.26***	1.43±0.35***	0.51±0.13***	1.17±0.30***	0.61±0.20***

Note: ***P<0.001 vs before treatment; ##P<0.01, ###P<0.001 vs. the control group after treatment. CAL: clinical attachment loss; SBI: sulcus bleeding index; GR: gingival recession; PLI: plaque index; TM: tooth mobility.

Table 3. Comparison of inflammatory factor levels in GCF before and after treatment ($\bar{x}$ ± sd, μg/L)

Group	Time	TNF-α	IL-1β	sICAM-1
Research group (n=55)	Before treatment	7.10±1.44	19.56±1.70	25.44±2.55
	2 months after treatment	4.65±1.06***,###	13.33±1.21***,###	13.20±2.60***,###
Control group (n=55)	Before treatment	6.97±1.30	19.07±1.93	24.97±3.03
	2 months after treatment	5.90±1.11***	16.01±1.03***	18.28±3.32***

Note: ***P<0.001 vs. before treatment; ###P<0.001 vs. the control group after treatment. TNF-α: tumor necrosis factor-α; IL-1β: interleukin-1β; sICAM-1: soluble intercellular adhesion molecule-1; GCF: gingival crevicular fluid.

Table 4. Comparison of inflammatory factor levels in serum before and after treatment ($\bar{x}$ ± sd, μg/L)

Group	Time	TNF-α	IL-1β	sICAM-1
Research group (n=55)	Before treatment	78.48±8.84	50.05±5.50	107.78±10.04
	2 months after treatment	57.70±7.40***,##	30.09±4.45***,###	68.90±8.60***,###
Control group (n=55)	Before treatment	79.04±9.35	51.10±6.29	108.47±11.22
	2 months after treatment	62.20±7.69***	39.98±5.48***	76.08±7.49***

Note: ***P<0.001 vs. before treatment; ##P<0.01, ###P<0.001 vs. the control group after treatment. TNF-α: tumor necrosis factor-α; IL-1β: interleukin-1β; sICAM-1: soluble intercellular adhesion molecule-1; PGE2: prostaglandin E2.

Table 5. Comparison of PGE2 levels in GCF before and after treatment ($\bar{x}$ ± sd)

Group	Time	PGE2 levels in GCF (μg/mL)
Research group (n=55)	Before treatment	13.28±2.77
	2 months after treatment	6.50±1.72***,###
Control group (n=55)	Before treatment	13.10±2.83
	2 months after treatment	8.89±1.84***

Note: ***P<0.001 vs. before treatment; ###P<0.001 vs. the control group after treatment. PGE2: prostaglandin E2; GCF: gingival crevicular fluid.

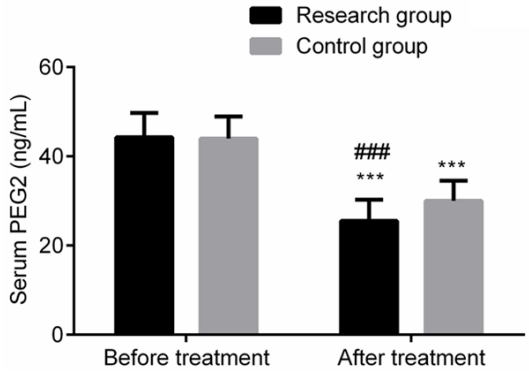

Figure 1. Comparison of serum PEG2 levels. ***P<0.001 vs. before treatment; ###P<0.001 vs. the control group after treatment. PGE2: prostaglandin E2.

used to measure the depth of a periodontal pocket and the thickness of plaque, which can simultaneously assess the therapeutic effect and oral hygiene status, with reduced PLI revealing improved oral hygiene status; TM mainly reflects the tooth mobility after alveolar bone resorption, and the tooth support gradually decreases as alveolar bone resorption becomes more severe (more severe alveolar bone resorption demonstrates higher TM); GR can show the gingival bleeding tendency in patients with periodontal diseases. Overall, these indicators can comprehensively reflect the periodontal status, and evaluate the oral hygiene status and treatment outcome of patients with periodontal diseases [12, 13].

Our study identified that the levels of inflammatory factors (e.g., TNF-α, IL-1β and sICAM-1) and PEG2 in GCF and serum of both groups were all decreased at 2 months after treatment. Besides, the research group revealed lower levels than the control group. The results suggest that both self-ligating and conventional brackets for chronic periodontitis patients undergoing orthodontic treatment can reduce the local periodontal and systemic inflammatory response, but the self-ligating brackets exert a better effect in reducing the inflammatory response, which was consistent with relevant prior studies [14, 15]. This is because self-ligating brackets have less stimulation to periodontal soft tissues with less friction, which reduces the possibility of bacterial invasion. Thus, it's more conducive to relieving the local periodontal inflammatory response and maintaining the oral microecological environment [16]. The inflammatory response plays an important role in the occurrence and development of chronic periodontitis. Pathogenic bacteria in periodontal pockets can activate the immune response, and stimulate lymphocytes, and monocytes, etc. for release of a large number of inflammatory cytokines and mediators, to participate in the occurrence and progression of the disease [17]. Hence, the levels of inflammatory factors, especially the levels in GCF, can intuitively and clearly reflect the periodontal inflammation in periodontitis patients in a better way [18]. TNF-α and IL-1β are both proinflammatory cytokines and powerful chemotactic factors, which can promote osteoclast activity, inhibit fibroblast alkaline phosphatase (AKP) activity, and thus damage periodontal soft tissues. Furthermore, TNF-α and IL-1β can also activate neutrophils, induce the release of other inflammatory cytokines, and further aggravate the body's inflammatory response [19]. sICAM-1, an important adhesion molecule involved in mediating the adhesion response, can enhance the adhesion between endothelial cells and inflammatory cells as its level increases [20]. Besides, PEG2 is bone resorption-stimulating factor, with higher levels in GCF indicating more severe periodontal tissue injury [21]. With a small sample size and limited follow-up time in this single-center study, we're aware that studies with larger sample sizes and deeper analyses are still needed to confirm the effect of self-ligating brackets in patients with chronic periodontitis undergoing orthodontic treatment in the future.

To sum up, self-ligating brackets for chronic periodontitis patients undergoing orthodontic treatment can significantly reduce the inflammatory response, effectively promote the periodontal status, and exert a favorable correction effect, which is worthy of clinical application.

Disclosure of conflict of interest

None.

Address correspondence to: Lian Zeng, Department of Oral Medicine, Yunnan Second People's Hospital, No. 176 Qingnian Road, Wuhua District, Kunming 650051, Yunnan Province, China. Tel: +86-0871-65156650-2823; E-mail: zenglian2hyn@163.com

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